ACTIVITY 08

Molecular Football - Fullerene Structures and Geometry

Illustration from the activity

Co-funded by the European Union

3D STEAM

Project: Accelerating STEAM-related Knowledge and Skills via 3D Modelling and 3D Printing
Reg. no. 2023-1-CZ01-KA220-HED-000160664

Teaching Planning Tool – 3D Modelling and 3D Printing (STEAM)

Template (2 parts: Conceptual Planning + Lesson Plan). Replace the square brackets with your own content.
3D printing and modelling as a tool for the creative development of students' knowledge and skills (original designs, iterations)

PART 1: Conceptual Planning (General Information)

Title of the Thematic (STEAM) Unit

Molecular Football – Fullerene Structures and Geometry

Authors (Names / School / Country): Experience Workshop, Finland

SUBJECT	Mathematics, Chemistry, Physics, Physical Education, Arts
YEAR	Grades 4–12
NUMBER OF LESSONS	1–2 lessons (90 minutes total)
DIDACTIC OBJECTIVES	Develop pattern recognition through observations and physical modelling. Explore problem-solving in 2D and 3D geometry. Understand fullerene structures and their scientific relevance.
SPECIFIC OBJECTIVES	Students recognize geometrical characteristics of everyday objects and scientific structures. Students understand the configuration of carbon molecules in Fullerenes and Nanotubes.

THEMATISATION AND PROBLEMATISATION

Why is the topic meaningful, and what problem does it address?
Key questions and didactic strategy (e.g. PBL, constructionism, EUR method).

The unit connects geometry, chemistry, physics and design through the familiar shape of a soccer ball. Students investigate how fullerene molecules resemble a truncated icosahedron and explore applications of symmetry in science, nanotechnology and everyday life. The didactic approach combines inquiry-based learning, constructionism and collaborative problem-solving.

Yes – Basics of TinkerCAD

Optional – Experience with GeoGebra3D

No – Working with STL/OBJ files

Optional – Basic slicing (PrusaSlicer / Cura / Bambu Studio)

Yes – Experience with other software (physical modelling kits or geometry tools)

Yes – 3D printing safety

3D TOOLS AND SOFTWARE

• Modelling software: TinkerCAD, GeoGebra 3D

• Slicer: PrusaSlicer or Bambu Studio

• Viewer/AR: Optional AR viewer or 3D object viewer

3D PRINTING

Equipment required for the activity:

3D modelling computers or tablets, internet access, 4Dframe or alternative construction kits (Zometool, JOVO, etc.), 3D printer, filament, projector, soccer balls and presentation slides.

Learning objectives related to 3D modelling and printing

Main objective:

Students understand fullerene geometry and model a truncated icosahedron through physical and digital 3D modelling.

Secondary objectives:

Students apply symmetry concepts, connect chemistry and mathematics, experiment with creative design modifications, and explore applications of nanotechnology and molecular structures.

STEAM Elements

STEAM ELEMENT	CHARACTERISTICS OF THE ELEMENT IN THE ACTIVITY
SCIENCE	Geometrical modelling of molecular structures and exploration of nanotechnology.
TECHNOLOGY	Use of 3D modelling software, digital design and 3D printing workflows.
ENGINEERING	Construction of fullerene and graphene structures using modular systems and 3D design.
ARTS	Creative model design, free play, aesthetics and visual exploration of symmetry.
MATHEMATICS	Exploration of truncated icosahedrons, pentagons, hexagons, Euler's formula and symmetry.

Syllabus of Cross-Curricular Links

SUBJECTS	AREA OF LEARNING	CONTENT STANDARD	PERFORMANCE STANDARD
Mathematics	Geometry and Symmetry	Understanding polygons and 3D geometry	Students recognize and model geometric structures
Chemistry	Carbon Structures	Understanding Fullerenes and Graphene	Students explain molecular geometry
Physics / Arts	Soccer Ball Design and Symmetry	Connections between aesthetics, movement and science	Students explore design principles creatively

PART 2: Specific Planning – Lesson Plan

Title of the Lesson: Molecular Football – Exploring Fullerene Structures Through Geometry and 3D Modelling

Lesson Objectives: Students explore the geometry of fullerene structures and soccer ball patterns, construct 3D models, investigate symmetry principles, and connect mathematics, chemistry, physics, arts and engineering through hands-on modelling.

Expected Student Outcomes: [List of specific outcomes]

Expected Student Outcomes: Students can identify fullerene geometry, construct 3D models, explain symmetry principles, and connect geometry with chemistry, physics, arts and engineering.

Lesson Plan (Phased Description)

Introduction (10 min): Study soccer ball patterns and discuss geometry and symmetry.

Learning Activities (60 min): Build fullerene and graphene structures physically or digitally. Explore pentagons, hexagons, Euler's formula and symmetry principles. Experiment with modifications and free-play activities.

3D Modelling and Printing: Create simplified fullerene structures in TinkerCAD or GeoGebra 3D. Prepare STL files and demonstrate slicing and 3D printing.

Wrap-Up and Reflection (20 min): Compare models, discuss scientific applications of Fullerenes, Graphene and virus structures, and create a collaborative concept map.

Assessment – Overview

Reflection / Evaluation – Feedback

Assessment of 3D Modelling and 3D Printing (Detailed)

1) Does the student understand / know …? – Method: [mind map]

2) Has the student created …? – Method: [product evaluation]

3) Can the student present …? – Method: [presentation, peer review]

4) Does the student implement / improve …? – Method: [prototype revision]

5) Teamwork …? – Method: [observation, self-assessment]

Additional Information (Optional)

Notes: Activity can be adapted for different age groups and levels of modelling experience.

Teaching Resources / Support Materials: Soccer balls, geometry slides, 4Dframe toolkit, TinkerCAD, GeoGebra 3D, Nobel Prize educational materials.

Evaluation Resources / Materials: Observation sheets, peer review forms, concept maps and model evaluation rubrics.

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3D STEAM

This material was developed within the framework of the Erasmus+ KA2 project named Accelerating STEAM-related Knowledge and Skills via 3D Modelling and 3D Printing (reg. no. 2023-1-CZ01-KA220-HED-000160664).

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